

Bitwise

The Case for Bitcoin in an Institutional Portfolio

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I. Executive Summary

This paper examines the case for adding bitcoin to a diversified portfolio of stocks and bonds. Specifically, we consider the impact that different allocations to bitcoin would have had on a Traditional Portfolio consisting of 60% equities and 40% bonds under a myriad of different market regimes.

The findings are remarkable.

The paper shows that bitcoin would have contributed positively to a diversified portfolio's cumulative and risk-adjusted returns in 74% of one-year periods, 97% of two-year periods, and 100% of three-year periods since 2014, assuming quarterly rebalancing.¹

In addition, the size of that positive impact has been significant: On average, assuming quarterly rebalancing, a 2.5% allocation to bitcoin would have boosted the three-year cumulative return of a traditional 60% equity/40% bond portfolio by an astonishing 15.9 percentage points.²

Counterintuitively, bitcoin has positively impacted portfolios even over periods in which bitcoin's price has declined. For instance, assuming quarterly rebalancing, an investor who first allocated to bitcoin at its all-time closing high on December 16, 2017, and held through the end of this study, would have had (modestly) higher cumulative and risk-adjusted returns than an investor who did not allocate to bitcoin at all, despite the fact that bitcoin fell 67% during this period. This remarkable result is driven by the fact that bitcoin has low correlations with other asset classes and daily liquidity, allowing investors to capitalize on the volatility harvesting opportunity that noncorrelated assets offer.³

The paper builds on a significant existing literature examining bitcoin's influence on portfolio returns. One common criticism of prior papers, however, is that the authors cherry-pick specific time periods, rebalancing strategies, or allocations to highlight positive results. The question that lingers in the back of many potential investors' minds is: "But what if I didn't allocate exactly this way?"

This paper aims to address this type of question by being comprehensive in all possible aspects. Specifically, it shows how key portfolio metrics would have fared considering:

- **Extensive price data**, considering prices from January 1, 2014, all the way through March 31, 2020;
- **All available time periods**, using rolling-period analyses to examine every possible one-, two-, and three-year holding periods within that history;
- **A range of potential bitcoin allocations**, from 0% to 10% of the portfolio; and
- **Multiple rebalancing frequencies**, including monthly, quarterly, annual, and no rebalancing.

There is, of course, no guarantee that the relationships between a bitcoin allocation and key portfolio performance metrics will persist going forward. But the results are strong enough to suggest that many institutional investors should carefully consider bitcoin as a portfolio asset.

¹ Although this study focuses on the period since 2014, the positive impact on a portfolio exists if the study is expanded to include all data. Looking at data from July 2010 through March 2020, bitcoin has contributed positively for the cumulative return of a Traditional Portfolio in 81.5% of one-year periods, 96.9% of two-year periods, and 100% of three-year periods, and to risk-adjusted returns a very similar 80.2% of one-year periods, 96.9% of two-year periods, and 100% of three-year periods.

² We examine other rebalancing strategies, holding periods, and allocation sizes in the body of the paper.

³ See, for instance, "Volatility Harvesting: Why Does Diversifying And Rebalancing Create Portfolio Growth?" by Paul Bouchev, Vassilii Nemtchinov, Alex Paulsen and David M. Stein, The Journal of Wealth Management, Vol. 15, No. 2, Fall 2012.

II. Methodology

This paper examines the impact of adding a bitcoin allocation to a traditional, diversified portfolio of stocks and bonds (the “Traditional Portfolio”).

The Traditional Portfolio features a 60% allocation to the Vanguard Total World Stock ETF (VT) and a 40% allocation to the Vanguard Total Bond Market ETF (BND). VT holds a market-cap-weighted portfolio of global stocks covering 98% of the world’s market capitalization, while BND holds a market-value-weighted portfolio representing all taxable, investment-grade U.S. bonds. This paper uses the total return track record of these funds, assuming all dividends are reinvested.

By contrast, in an effort to present the most conservative position, the study uses bitcoin’s price return, and does not add in the value of hard forks or airdrops. In practice, an investor allocating to bitcoin would have achieved a meaningfully higher total return by capturing the value of those distributions over the study period.

The paper focuses on the period between January 1, 2014, and March 31, 2020, removing the first 3.5 years of bitcoin’s returns. The decision to remove these years was made in an effort to better represent the modern experience of professional asset allocators in the U.S. It should be noted that including this earlier period would only have strengthened the findings of this paper, as bitcoin’s returns during this period were exceptionally strong: Bitcoin returned 506% from July 17, 2010, through December 31, 2010; 1,474% in 2011; 186% in 2012; and 5,537% in 2013, for a cumulative return over the roughly 3.5-year period of 1,537,795%.

Importantly, the paper takes advantage of both point-in-time and rolling period analyses. For rolling analyses, instead of looking at arbitrary start and end dates, we fix a certain holding period window (e.g., three years, two years, or one year) and analyze all possible holding periods of that length. We find rolling period analyses useful because they eliminate concerns about cherry-picking specific time periods, and because they provide a fuller view of the frequency and magnitude of the impact a bitcoin allocation can have on a portfolio under different market regimes.

Aside from cumulative and annualized returns, this analysis also delves into key portfolio performance metrics like Sharpe ratios⁴, standard deviations, and maximum drawdowns.

Pricing data used throughout this study was sourced from Yahoo Finance for traditional assets and from our internal database for bitcoin.⁵ All returns are calculated daily and normalized for official market trading days. This means that bitcoin returns over weekends or market holidays are accounted for in the following official market trading session.

⁴ This paper uses a risk-free rate of 0.7% per year to calculate the Sharpe ratio. This was the 10-year Treasury yield at the cutoff date of our analysis (March 31, 2020).

⁵ Bitwise Asset Management calculates bitcoin reference prices daily by averaging the prices from select exchanges. Prices were collected at midnight UTC before July 31, 2018 and at 4pm ET thereafter.

III. Bitcoin's Impact On A 60/40 Traditional Portfolio

HOW ADDING BITCOIN TO A TRADITIONAL PORTFOLIO WOULD HAVE IMPACTED RETURNS

We begin this study with a classic 60/40 Traditional Portfolio, initially without a bitcoin allocation. From the start of our primary study period on January 1, 2014 until March 31, 2020, this portfolio returned 26.2%, which translates into an annualized return of 3.8% per year.

As the chart and the table below show, a modest allocation to bitcoin would have significantly improved these returns.

For example, adding a 2.5% bitcoin allocation with quarterly rebalancing⁶ would have improved the cumulative return of the portfolio from 26.2% to 44.9%. Importantly, this result would have been achieved without significantly changing either the portfolio's volatility (10.1% with bitcoin, up from 9.9% without) or its maximum drawdowns (21.8% with bitcoin, up from 21.1% without). The portfolio's Sharpe ratio, which measures excess returns per unit of risk, would have improved by a whopping 71.4%.

Naturally, bitcoin's portfolio impact has scaled with the size of the allocation: A 5% allocation to bitcoin would have boosted the cumulative return of the portfolio to 65.1%, more than doubling the total return of the Traditional Portfolio. That is a remarkable impact considering the relatively small size of the allocation.

A 2.5% allocation to bitcoin would have improved the return of a diversified portfolio by 18.7 percentage points between January 1, 2014, and March 31, 2020.

CUMULATIVE RETURNS – TRADITIONAL PORTFOLIO WITH AND WITHOUT QUARTERLY-REBALANCED BITCOIN ALLOCATIONS

Period between January 1, 2014 and March 31, 2020



Source: Bitwise Asset Management

⁶ We examine the impact of other rebalancing frequencies—as well as strategies that involve no rebalancing—later in the paper. As those studies show, more frequent rebalancing strategies generally have two impacts: 1) reducing the positive impact on cumulative returns from adding bitcoin to a portfolio; and 2) reducing the impact on the portfolio's volatility. In other words, the more frequent the rebalancing, the lower the risk ... and the lower the reward.

PORTFOLIO PERFORMANCE METRICS

Period between January 1, 2014 and March 31, 2020 (assuming quarterly rebalancing)

PORTFOLIO	CUMULATIVE RETURN	ANNUALIZED RETURN	VOLATILITY (ANNUALIZED STD. DEV.)	SHARPE RATIO	MAXIMUM DRAWDOWN
Traditional Portfolio	26.22%	3.80%	9.86%	0.31	21.07%
Traditional Portfolio + 1.0% bitcoin	33.52%	4.74%	9.87%	0.41	21.32%
Traditional Portfolio + 2.5% bitcoin	44.91%	6.13%	10.07%	0.54	21.80%
Traditional Portfolio + 5.0% bitcoin	65.07%	8.37%	10.83%	0.70	22.76%

Source: Bitwise Asset Management

It is fair to note that the price of bitcoin rose sharply during this period, from \$755 at the start of 2014 to \$6,479 on March 31, 2020. A natural follow-up question is, how would allocating to bitcoin have impacted a portfolio during less exuberant cryptoasset markets?

Bitcoin has never experienced a multiyear bear market, but we can look at idiosyncratic periods of significant drawdowns to answer this question. For example: What would have happened if you had started an allocation on December 16, 2017, when bitcoin hit its all-time high daily closing price of \$19,397, and held through the end of our study period on March 31, 2020, when bitcoin closed at \$6,479? That represents a punishing 66.6% decline for bitcoin.

Interestingly, even under such an adverse scenario, a quarterly rebalanced allocation to bitcoin would have delivered a slight, but nonetheless positive, impact on both the cumulative and risk-adjusted returns of a Traditional Portfolio. For example, a 2.5% allocation to bitcoin would have increased the cumulative return of a Traditional Portfolio by 0.6 percentage points and expanded its Sharpe ratio by 0.2 points.

How can an asset that declines 66.6% boost the returns of a portfolio? The answer comes from bitcoin's unique return profile, which combines significant volatility and a lack of correlation with other assets. As discussed in "Volatility Harvesting: Why Does Diversifying And Rebalancing Create Portfolio Growth" (Bouchey et al.), applying a disciplined rebalancing strategy to a volatile, noncorrelated asset often yields positive portfolio impacts.⁷

A bitcoin allocation would have contributed positively to the Traditional Portfolio's returns even if the allocation started at bitcoin's all-time high price (assuming quarterly rebalancing).

CUMULATIVE RETURNS – TRADITIONAL PORTFOLIO WITH AND WITHOUT QUARTERLY-REBALANCED BITCOIN ALLOCATIONS

Period between December 16, 2017 and March 31, 2020

● 1.0% Bitcoin Allocation ● 2.5% Bitcoin Allocation ● 5.0% Bitcoin Allocation ● Traditional Portfolio



Source: Bitwise Asset Management

⁷ Volatility Harvesting: Why Does Diversifying And Rebalancing Create Portfolio Growth, by Paul Bouchey, Vassilii Nemtchinov, Alex Paulsen and David M. Stein, The Journal of Wealth Management, vol. 15, No. 2, Fall 2012.

PORTFOLIO PERFORMANCE METRICS

Period between December 16, 2017 and March 31, 2020 (assuming quarterly rebalancing)

PORTFOLIO	CUMULATIVE RETURN	ANNUALIZED RETURN	VOLATILITY (ANNUALIZED STD. DEV.)	SHARPE RATIO	MAXIMUM DRAWDOWN
Traditional Portfolio	-0.54%	-0.24%	13.10%	(0.103)	21.07%
Traditional Portfolio + 1.0% bitcoin	-0.51%	-0.23%	13.09%	(0.102)	21.10%
Traditional Portfolio + 2.5% bitcoin	0.05%	0.02%	13.27%	(0.083)	21.80%
Traditional Portfolio + 5.0% bitcoin	0.40%	0.17%	13.88%	(0.068)	22.76%

Source: Bitwise Asset Management

GENERALIZING BITCOIN'S PORTFOLIO IMPACT THROUGH ROLLING ANALYSES

While the above studies are illustrative, it is possible to have a fuller understanding of the impact a bitcoin allocation has had on a Traditional Portfolio by looking at rolling return periods rather than arbitrary start and end dates.

For the rolling period analyses, we fix a certain holding period window (e.g., three years, two years, or one year) and analyze all possible holding periods of that length.

For now, we will consider the impact of a 2.5% allocation to bitcoin over a three-year rolling period, using a quarterly rebalancing frequency. Later, we will analyze the impact of different allocation sizes, holding periods, and rebalancing frequencies.

The results of this analysis are remarkable, showing that bitcoin would have contributed positively to the cumulative three-year return of a Traditional Portfolio for every possible start date in its history.

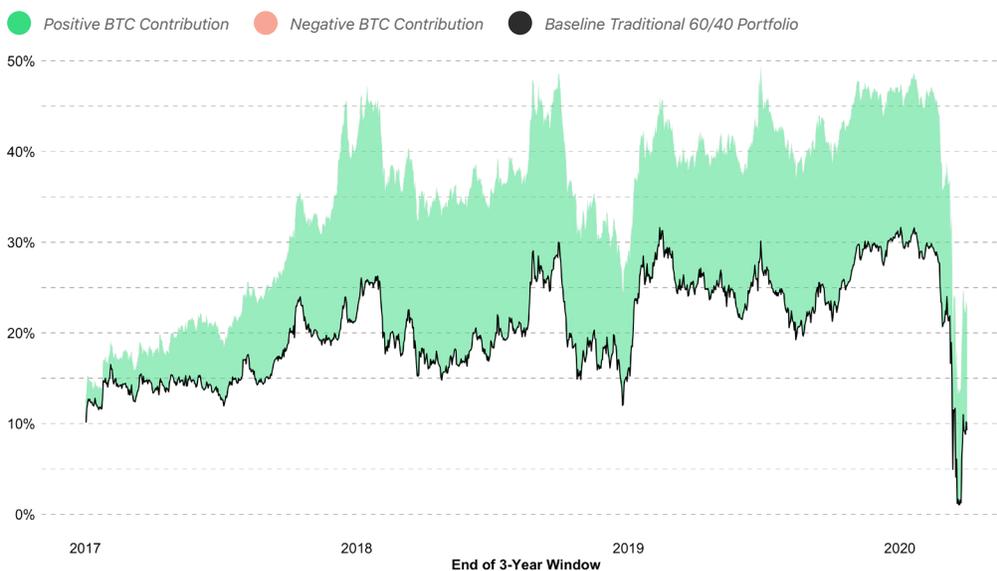
The chart on the following page depicts the impact of such allocation, zooming in on the period between the start of 2014 and March 31, 2020. That means the first data point on the chart includes returns between January 1, 2014 and January 1, 2017, while the last data point refers to returns between March 31, 2017 and March 31, 2020. The other data points represent all three-year windows between these two.

The black line represents the three-year rolling returns of the Traditional Portfolio, while the green shade shows the positive contribution that a bitcoin allocation brings.

Adding bitcoin has increased the cumulative three-year return of a Traditional Portfolio for every possible start date in bitcoin's history.

CONTRIBUTION OF A 2.5% BITCOIN ALLOCATION TO A 60/40 PORTFOLIO

Three-year rolling cumulative return for the periods between January 1, 2014 and March 31, 2020



Source: Bitwise Asset Management

It is worth noting the scale of the impact.

At the far left of the chart, covering the period from January 1, 2014 through January 1, 2017, the 2.5% allocation to bitcoin boosted the portfolio's cumulative return from 10.2% to 12.7%, a gain of 2.5 percentage points.⁸ That's remarkable: The portfolio impact equaled the size of the allocation itself.

It turns out that this was one of the worst three-year periods in bitcoin's return history.

Consider, for instance, the last point on the chart, for the period ending March 31, 2020. This period includes bitcoin's 80% drawdown in 2018. Despite the volatility, adding a 2.5% allocation to bitcoin over this time period boosted the portfolio's returns from 9.3% to 22.5%, an outstanding improvement of 13.3 percentage points.

Remarkably, even this is below the median impact. While the size of the impact ebbs and flows throughout the study period, the median contribution of a 2.5% allocation to bitcoin on the three-year return of a Traditional Portfolio during this period was a remarkable 15.9 percentage points.

CONTRIBUTION OF 2.5% ALLOCATION TO THE TRADITIONAL PORTFOLIO

Three-year rolling cumulative return for the periods between January 1, 2014 and March 31, 2020

Maximum Contribution	22.39 pp
Median Contribution	15.87 pp
Minimum Contribution	1.83 pp
Frequency of Positive Contributions	100.00%
Frequency of Negative Contributions	0.00%

Source: Bitwise Asset Management

⁸ The contribution of a bitcoin allocation is hereby measured in the actual amount instead of in the rate of change in order to avoid potential ambiguity coming from relatively small denominators or signal changes. For example: if the Traditional Portfolio returned 1% while the same portfolio with a bitcoin allocation returned 2%, the impact will be presented as a 1 percentage point (pp) positive impact instead of as a 100% boost in returns; conversely, if the Traditional Portfolio has a Sharpe ratio of 1.00 while the same portfolio with a bitcoin allocation has a Sharpe ratio of 1.20, the impact will be presented as 0.20 point instead of 20%.

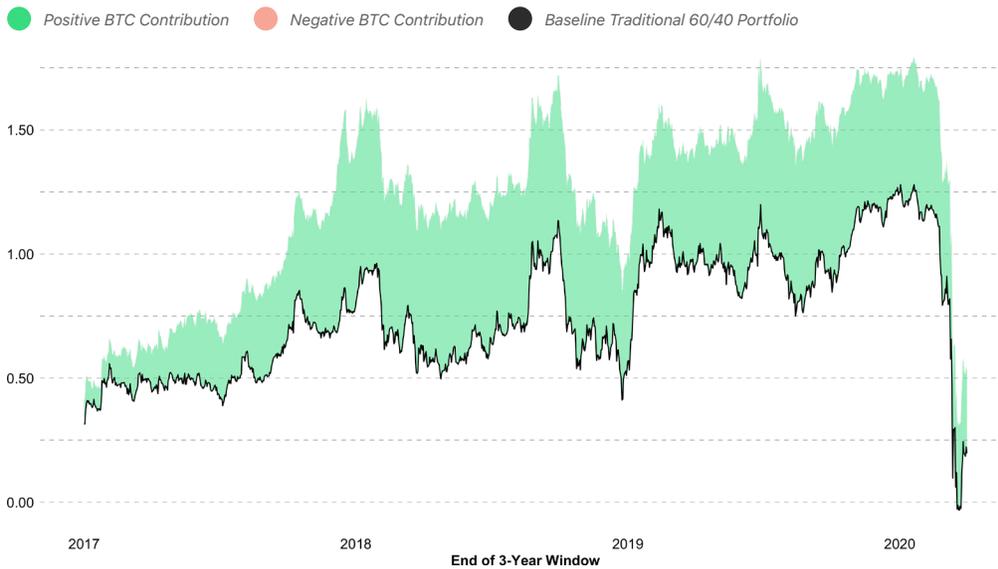
Importantly, the positive contribution from a bitcoin allocation does not come at the expense of excess volatility. Just as with cumulative returns, a bitcoin allocation had a positive impact on the Traditional Portfolio's accumulated Sharpe ratio for every possible three-year window.

The chart below shows the improvement to a Traditional Portfolio's Sharpe ratio over rolling three-year windows. In this case, the median result boosts the Sharpe ratio by 0.51 points; the worst three-year period boosts the Sharpe ratio by "only" 0.07. This means that the small increase in annualized volatility that crypto adds to the Traditional Portfolio was more than compensated for by its excess returns.

Adding bitcoin to a portfolio would also have significantly boosted its risk-adjusted returns, as measured by the Sharpe ratio.

CONTRIBUTION OF A 2.5% BITCOIN ALLOCATION TO A 60/40 PORTFOLIO

Three-year rolling Sharpe ratio for the periods between January 1, 2014 and March 31, 2020



Source: Bitwise Asset Management

As these studies show, it is hard to overstate the power and consistency of bitcoin as an enhancer of diversified portfolios.

IV. The Three Key Questions When Allocating To Bitcoin

Investors allocating to bitcoin must answer three critical questions:

- 1) What is the minimum acceptable holding period for a bitcoin allocation?
- 2) What is the best rebalancing frequency for a bitcoin allocation?
- 3) How much bitcoin should you add to a portfolio?

We have evaluated each of these questions separately to help investors make the best possible decisions in light of the available historical data.

QUESTION 1:

WHAT IS THE MINIMUM ACCEPTABLE HOLDING PERIOD FOR A BITCOIN ALLOCATION?

To examine the most appropriate holding period, we rerun the rolling return and Sharpe ratio exercise for holding periods varying from one to three years, using a 2.5% bitcoin allocation and quarterly rebalancing as the base case.

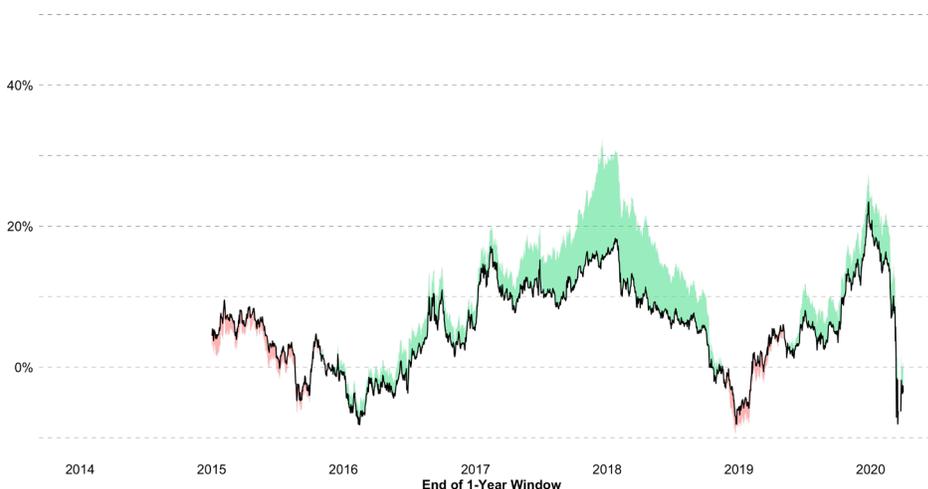
As discussed in the Executive Summary, this analysis shows that bitcoin's generally positive contribution to a portfolio's returns remains strong over all time periods studied. Specifically, bitcoin had a positive impact on one-year returns 74% of the time, on two-year returns 97% of the time, and on three-year returns 100% of the time.

The charts below show that impact with data since 2014:

CONTRIBUTION OF A 2.5% BITCOIN ALLOCATION TO A 60/40 PORTFOLIO

One-year rolling cumulative return for the periods between January 1, 2014 and March 31, 2020

● Positive BTC Contribution ● Negative BTC Contribution ● Baseline Traditional 60/40 Portfolio

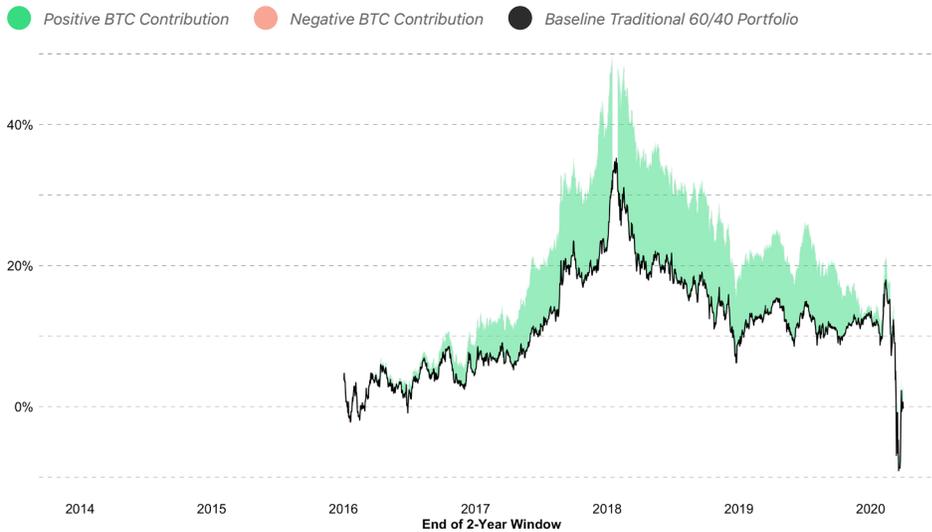


Source: Bitwise Asset Management

As the holding period of a bitcoin allocation goes to two years and higher, the frequency of positive contributions quickly approaches 100%.

CONTRIBUTION OF A 2.5% BITCOIN ALLOCATION TO A 60/40 PORTFOLIO

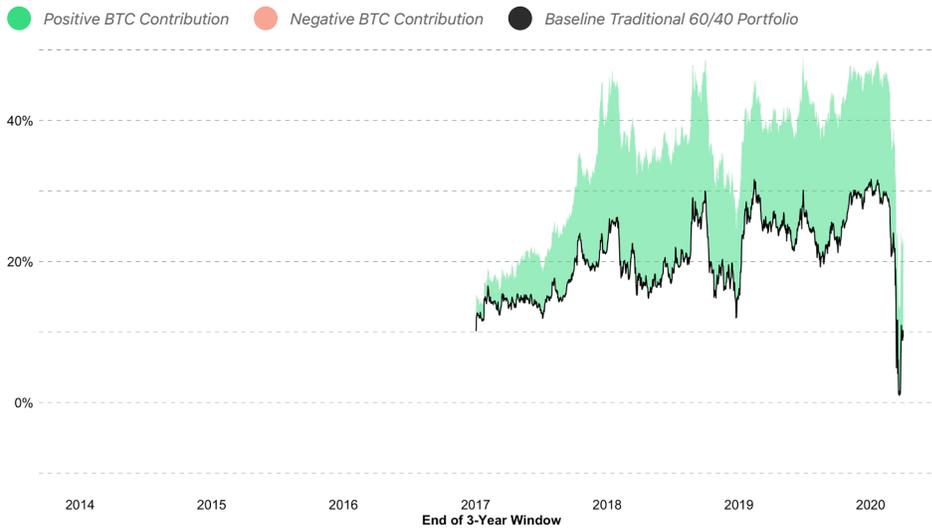
Two-year rolling cumulative return for the periods between January 1, 2014 and March 31, 2020



Source: Bitwise Asset Management

CONTRIBUTION OF A 2.5% BITCOIN ALLOCATION TO A 60/40 PORTFOLIO

Three-year rolling cumulative return for the periods between January 1, 2014 and March 31, 2020



Source: Bitwise Asset Management

It is worth noting that, even in the one-year study where negative contributions occur, the impact is asymmetrically positive: The median positive contribution to cumulative returns was 5.8 percentage points, while the median negative contribution was only -1.6 percentage points. This asymmetric skew persists even at the most extreme outcomes: The best-case contribution was 16.7 percentage points, while the worst-case contribution had a -3.0 percentage points impact on returns.⁹

The table below shows detailed results for one-year, two-year, and three-year holding periods. Investors can use the win rates and average contribution statistics as a historical reference of minimum holding periods. Certainly, by the time you get to a two-year holding period and a 97% win rate, the evidence for including a bitcoin allocation is compelling. Equally, as you shorten the time horizon, you take on more risk of a negative result.

⁹ As this statistic points out, one negative impact of rebalancing is that you can lose more than your original investment. In this worst-case one-year period, for instance, the portfolio impact is -3%, despite the 2.5% initial allocation, because the rebalancing discipline forced the portfolio to "average down" into the position.

CONTRIBUTION OF A 2.5% BITCOIN ALLOCATION TO A TRADITIONAL PORTFOLIO USING QUARTERLY REBALANCING

Rolling portfolio metrics for the periods between January 1, 2014 and March 31, 2020

HOLDING PERIOD	ROLLING CUMULATIVE RETURN CONTRIBUTION					ROLLING SHARPE RATIO CONTRIBUTION				
	MAXIMUM	MEDIAN	MINIMUM	WIN RATE	LOSS RATE	MAXIMUM	MEDIAN	MINIMUM	WIN RATE	LOSS RATE
1 Year	16.70 pp	3.07 pp	-3.00 pp	74.43%	25.57%	2.03	0.33	-0.45	74.43%	25.57%
2 Years	20.27 pp	8.68 pp	-0.65 pp	96.52%	3.48%	1.10	0.45	-0.04	96.52%	3.48%
3 Years	22.39 pp	15.87 pp	1.83 pp	100.00%	0.00%	0.74	0.51	0.07	100.00%	0.00%

Source: Bitwise Asset Management

QUESTION 2:

WHAT IS THE BEST REBALANCING FREQUENCY FOR A BITCOIN ALLOCATION?

The decision on how frequently to rebalance a portfolio carries extra weight when dealing with an asset with bitcoin's historical level of upside volatility. Absent rebalancing, even a small allocation to bitcoin can grow to dominate a portfolio's risk/return characteristics.

We now compare the cumulative and risk-adjusted returns of a Traditional Portfolio enhanced with a bitcoin allocation under four different rebalancing strategies: no rebalancing, monthly, quarterly, and annual rebalancing.¹⁰

The chart and table below highlight the substantial impact that a rebalancing strategy can have on bitcoin's impact on a portfolio. As might be expected with a highly volatile but upwardly biased asset, lower rebalancing frequencies generally lead to higher volatility, higher cumulative returns, and significantly higher maximum drawdowns. Conversely, more frequent rebalancing strategies dampen both the volatility and return impact.

More frequent rebalancing strategies would have reduced the portfolio's volatility and drawdowns. Less frequent rebalancing strategies would have generated stronger returns.

IMPACT OF DIFFERENT REBALANCING STRATEGIES ON 2.5% BTC PORTFOLIO

Period between January 1, 2014 and March 31, 2020

- Traditional Portfolio
- 2.5% BTC Allocation Monthly Rebalance
- 2.5% BTC Allocation Yearly Rebalance
- 2.5% BTC Allocation No Rebalance
- 2.5% BTC Allocation Quarterly Rebalance



Source: Bitwise Asset Management

¹⁰ Our 2018 study focused on a tolerance-based rebalancing strategy; extensive feedback from clients, however, suggest that most use calendar-based rebalancing. If anyone is interested in seeing the results of this study using a tolerance-based rebalancing strategy, please reach out to your Bitwise representative or email sales@bitwiseinvestments.com. The results are largely in line with the quarterly rebalancing strategy highlighted here.

PORTFOLIO PERFORMANCE METRICS

Period between January 1, 2014 and March 31, 2020

PORTFOLIO	CUMULATIVE RETURN	ANNUALIZED RETURN	VOLATILITY (ANNUALIZED STD. DEV.)	SHARPE RATIO	MAXIMUM DRAWDOWN
Traditional Portfolio	24.00%	3.51%	10.34%	0.270	22.91%
2.5% Bitcoin Allocation – No rebalancing	42.17%	5.80%	14.14%	0.358	32.25%
2.5% Bitcoin Allocation – Yearly rebalancing	67.18%	8.59%	11.02%	0.711	21.80%
2.5% Bitcoin Allocation – Quarterly Rebalancing	44.91%	6.13%	10.07%	0.535	21.80%
2.5% Bitcoin Allocation – Monthly Rebalancing	38.03%	5.30%	10.09%	0.453	22.31%

Source: Bitwise Asset Management

There is a clear relationship between cumulative returns and volatility. Adding bitcoin to a portfolio and not rebalancing led to a massive jump in portfolio volatility (from 10.3% to 14.1%), and a dramatic uptick in maximum drawdown (from 22.9% to 32.3%).

Adding any rebalancing strategy, however—monthly, quarterly, or annually¹¹—dramatically lowers the volatility impact. This leads to substantially higher Sharpe ratios for strategies with rebalancing in place.

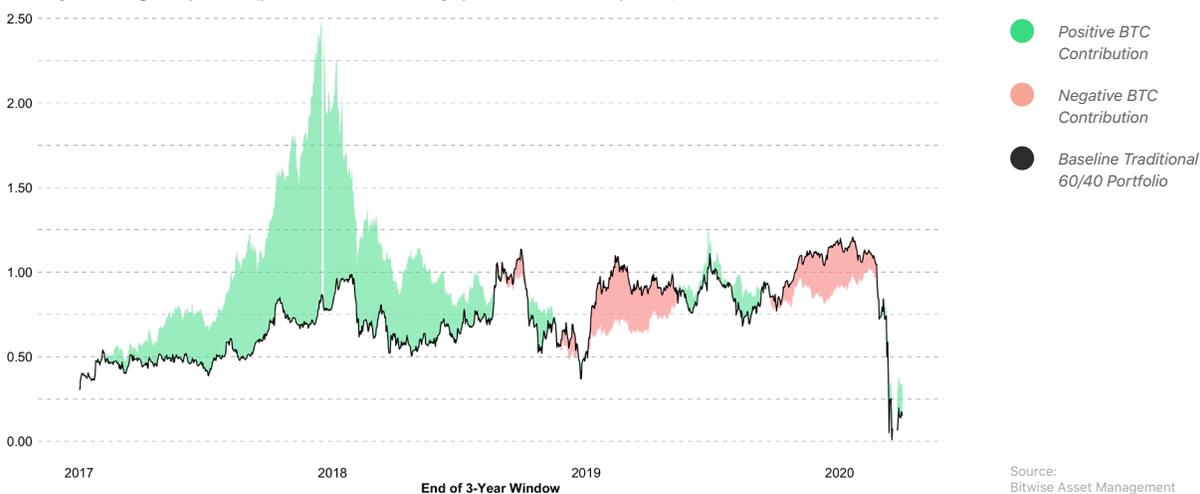
Interestingly, the return impact of the “no rebalancing” strategy is lower than that of either the quarterly or yearly rebalancing strategy, even though the impact on volatility is much higher. This showcases the impact of volatility harvesting on returns, and further demonstrates the importance of having a robust rebalancing strategy in place.

The charts below use rolling-period analysis to better visualize the impact that rebalancing has on portfolio outcomes. It shows, for instance, that the contribution of a bitcoin allocation to the Traditional Portfolio's Sharpe ratio is positive 69% of the time when not rebalanced, versus 100% with any sort of rebalancing. Also, the median portfolio contribution is significantly lower for the nonrebalanced portfolio versus its rebalanced peers.

The charts show that rebalancing regularly has been key to successfully using bitcoin in a portfolio setting.

NO REBALANCING – CONTRIBUTION OF 2.5% BITCOIN ALLOCATION TO A 60/40 PORTFOLIO

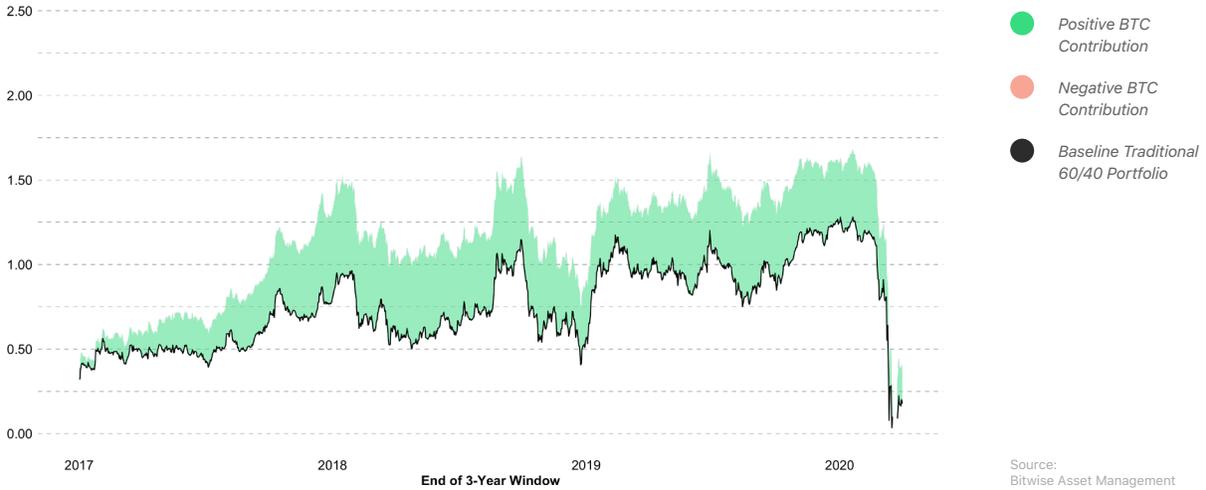
Three-year rolling Sharpe ratio (period between January 1, 2014 and March 31, 2020)



¹¹ An important portion of the returns generated by the annual rebalancing strategy comes from the coincidentally beneficial decision to rebalance at the end of 2017, near the all-time highs of bitcoin, and at the end of both 2014 and 2018, near the bottom of the last two bear market cycles.

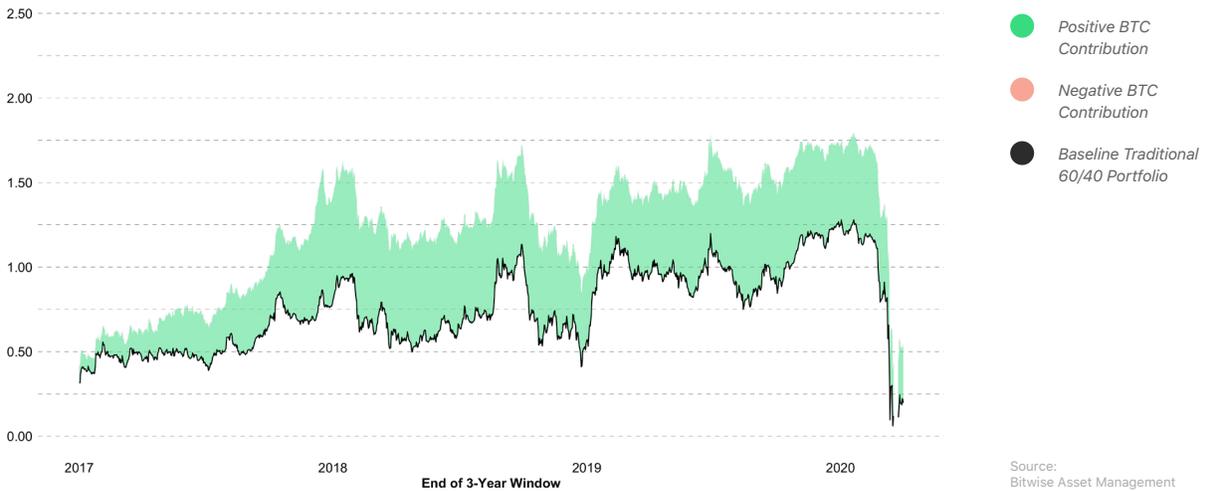
MONTHLY REBALANCING – CONTRIBUTION OF 2.5% BITCOIN ALLOCATION TO A 60/40 PORTFOLIO

Three-year rolling Sharpe ratio (period between January 1, 2014 and March 31, 2020)



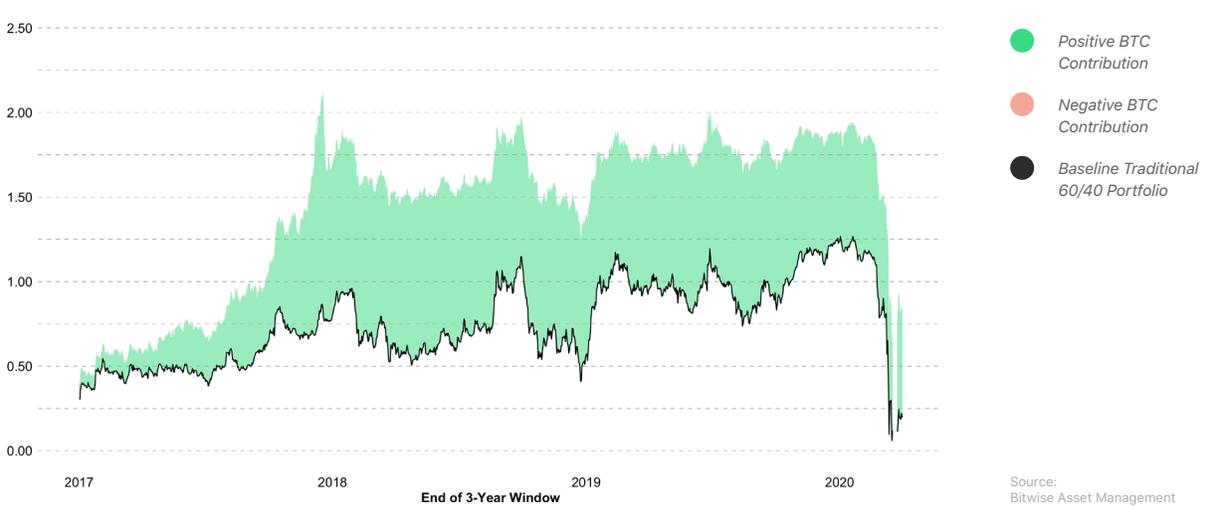
QUARTERLY REBALANCING – CONTRIBUTION OF 2.5% BITCOIN ALLOCATION TO A 60/40 PORTFOLIO

Three-year rolling Sharpe ratio (period between January 1, 2014 and March 31, 2020)



YEARLY REBALANCING – CONTRIBUTION OF 2.5% BITCOIN ALLOCATION TO A 60/40 PORTFOLIO

Three-year rolling Sharpe ratio (period between January 1, 2014 and March 31, 2020)



QUESTION 3:

HOW MUCH BITCOIN SHOULD YOU ADD TO A PORTFOLIO?

Perhaps the most important question when allocating to crypto is, how big a position should you have?

The four figures below answer that question.

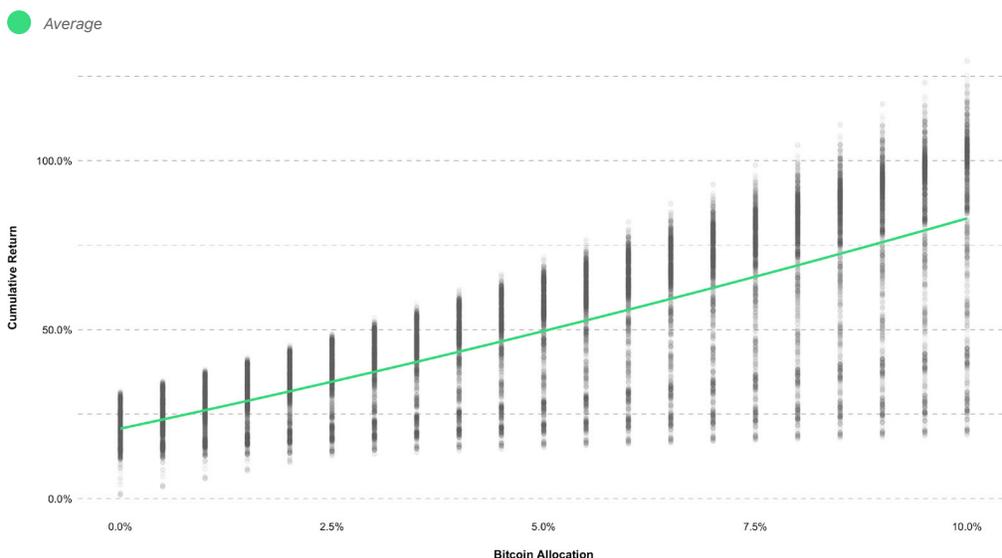
The figures show the impact allocating between 0% and 10% of a portfolio to bitcoin would have had over a three-year period on cumulative return, standard deviation, Sharpe ratio, and maximum drawdown, respectively.

The figures are informationally dense and bear explanation.

On each figure, the X-axis represents the amount of bitcoin added to the portfolio, from 0% (on the far left) to 10% (on the far right), increasing in 0.50% increments. The Y-axis represents the portfolio performance metric being studied. For instance, in the figure below, the Y-axis represents the cumulative return of the portfolio over a three-year time period.

THREE-YEAR ROLLING CUMULATIVE RETURN BY BITCOIN ALLOCATION

Period from January 1, 2014 to March 31, 2020 (assuming quarterly rebalancing)



Source: Bitwise Asset Management

The vertical gray lines are composed of a series of dots. Each dot represents the result for a single three-year period given the bitcoin allocation indicated by the X-axis. So, for instance, the dots in the left-most line represents the various three-year returns experienced by portfolios with a 0% allocation to bitcoin; the second column represents the returns experienced by portfolios with a 0.5% allocation to bitcoin; and so on. There are 1,185 dots in each vertical line, representing all possible three-year holding periods during our study window of January 1, 2014 through March 31, 2020.

The green line highlights the median result.

The cumulative return figure tells a clear story: The more bitcoin the better. As the green line shows, there is nearly a linear relationship between the amount of bitcoin added to the portfolio and the cumulative return.

That return, however, at comes with the potential drawback of added volatility.

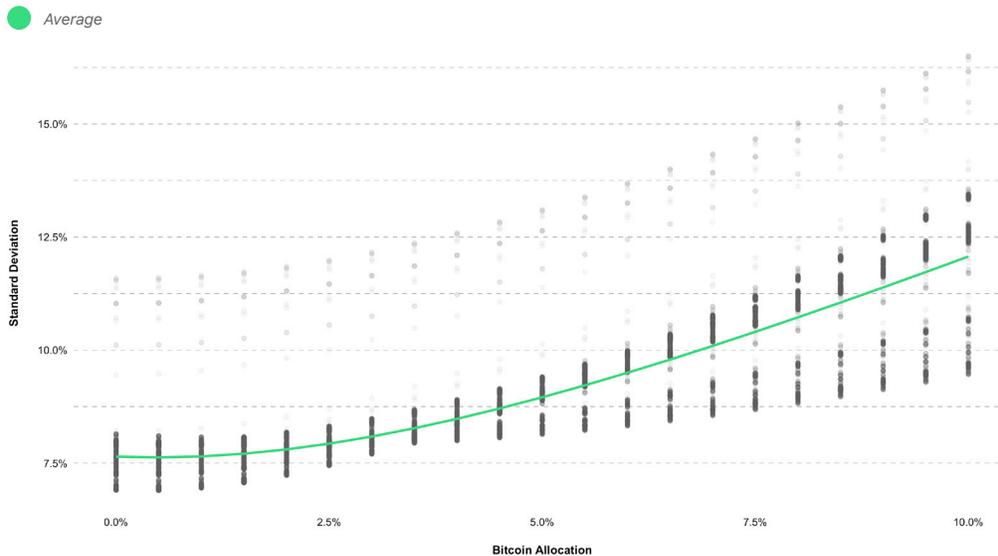
The following figure shows the impact of higher bitcoin allocations on standard deviation, a common measure of portfolio volatility. Clearly, as the bitcoin allocation increases, the portfolio's volatility does as well.

Interestingly, however, the relationship here is not linear; the green line has a distinctive swoosh-like shape. This suggests that small allocations to bitcoin—roughly between 0.5% and 3.0%—have a minimal impact on portfolio volatility, but that the impact increases quickly as the size of the allocation goes up.

Above a 3% allocation, adding bitcoin to a portfolio meaningfully increases the portfolio's volatility.

THREE-YEAR ROLLING STANDARD DEVIATION BY BITCOIN ALLOCATION

Period from January 1, 2014 to March 31, 2020 (assuming quarterly rebalancing)



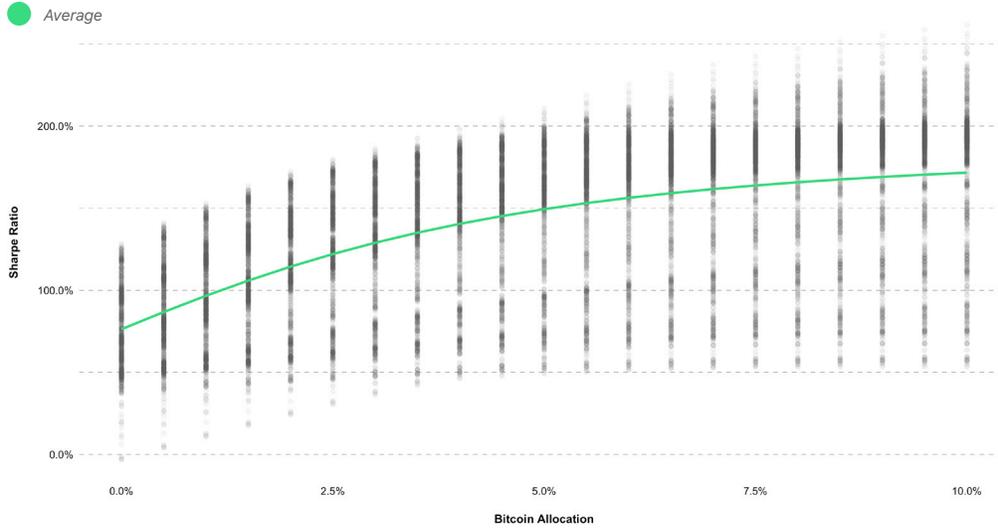
Source: Bitwise Asset Management

The next figure combines the previous two by examining Sharpe ratios. Like the standard deviation figure, this one has a distinct shape, rising sharply at first and then flattening out as the size of the portfolio allocation increases.

The right way to interpret the chart below is that adding bitcoin to a portfolio tends to increase risk-adjusted returns, but that the incremental benefit of adding more bitcoin to a portfolio diminishes once allocations go beyond the 3-4% range.

THREE-YEAR ROLLING SHARPE RATIO BY BITCOIN ALLOCATION

Period from January 1, 2014 to March 31, 2020 (assuming quarterly rebalancing)



Source: Bitwise Asset Management

The final chart is the most telling of the four; it looks at the impact that different allocations to bitcoin had on a portfolio's maximum drawdown.

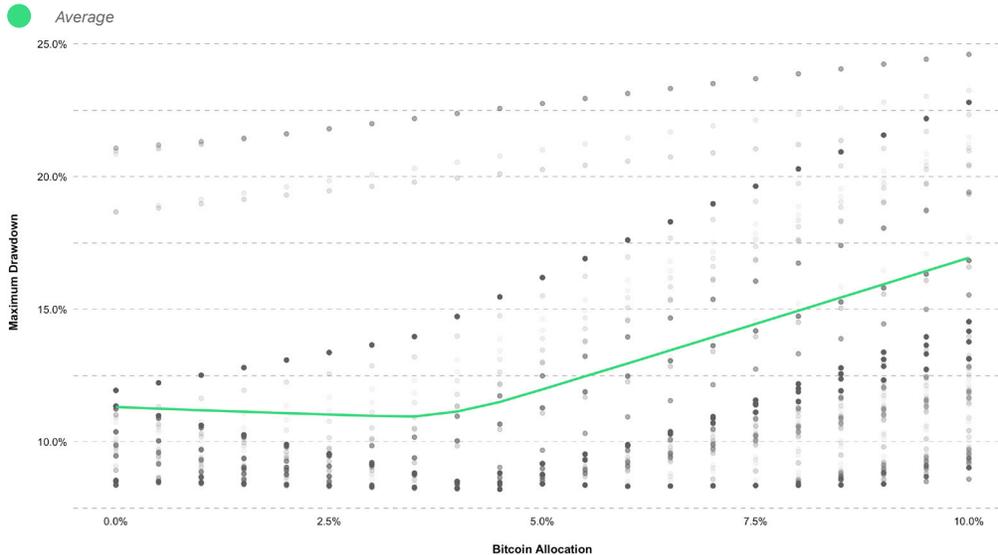
The shape of the green line's curve here is notable. It shows that adding bitcoin to a portfolio has, on average, reduced a portfolio's maximum drawdown over three-year periods for allocations between 0.5-3.5%. This fact may surprise some observers, as bitcoin itself is very volatile. Bitcoin's returns, however, are not typically correlated with stocks or bonds, which can help cushion the portfolio against stock and bond pullbacks.

Things change above a 3.5% bitcoin allocation, however. At these higher levels, the bitcoin allocation itself becomes a major driver of maximum drawdowns. By the time the allocation gets to 5% of the portfolio, the average bitcoin-enhanced portfolio's drawdown begins to exceed that of a portfolio without bitcoin.

The most crucial portfolio metric for investors to consider when sizing a bitcoin allocation has been maximum drawdown.

THREE-YEAR ROLLING MAXIMUM DRAWDOWN BY BITCOIN ALLOCATION

Period from January 1, 2014 to March 31, 2020 (assuming quarterly rebalancing)



Source: Bitwise Asset Management

Maximum drawdowns can have a significant impact on investor psychology and behavior. Given this, we believe most investors will be most comfortable with a bitcoin allocation of 5% or less. Beyond that number, the impact on the maximum drawdown may be more than some investors can bear.

The table below summarizes the impact of different bitcoin allocations on all four of the key portfolio metrics over the three-year period studied.

KEY PORTFOLIO METRICS BY BITCOIN ALLOCATION

Three-year rolling analysis from January 1, 2014 to March 31, 2020 (assuming quarterly rebalancing)

BITCOIN ALLOCATION	CUMULATIVE RETURN			SHARPE RATIO			STANDARD DEVIATION			MAXIMUM DRAWDOWN		
	MIN.	AVG.	MAX	MIN.	AVG.	MAX	MIN.	AVG.	MAX	MIN.	AVG.	MAX
0% <i>(Traditional Portfolio)</i>	1.05%	20.70%	31.64%	(0.032)	0.762	1.279	6.90%	7.64%	11.60%	8.37%	11.31%	21.07%
1%	5.88%	26.14%	38.28%	0.110	0.966	1.533	6.95%	7.65%	11.65%	8.42%	11.19%	21.32%
2%	10.66%	31.74%	45.47%	0.241	1.143	1.724	7.23%	7.80%	11.85%	8.34%	11.08%	21.61%
3%	13.21%	37.52%	53.55%	0.361	1.289	1.866	7.69%	8.09%	12.17%	8.27%	10.98%	22.00%
4%	14.20%	43.47%	61.91%	0.464	1.404	1.988	7.99%	8.48%	12.60%	8.20%	11.14%	22.38%
5%	15.17%	49.59%	71.51%	0.491	1.494	2.106	8.13%	8.96%	13.11%	8.41%	11.98%	22.76%
6%	16.13%	55.89%	82.02%	0.514	1.563	2.254	8.31%	9.50%	13.70%	8.32%	12.96%	23.13%
7%	16.93%	62.38%	93.03%	0.527	1.616	2.373	8.54%	10.09%	14.34%	8.34%	13.95%	23.51%
8%	17.56%	69.04%	104.63%	0.531	1.658	2.471	8.81%	10.72%	15.03%	8.36%	14.94%	23.88%
9%	18.16%	75.89%	116.92%	0.533	1.690	2.550	9.12%	11.39%	15.76%	8.41%	15.94%	24.24%
10%	18.75%	82.93%	129.72%	0.532	1.716	2.617	9.45%	12.07%	16.51%	8.59%	16.94%	24.61%

Source: Bitwise Asset Management

V. Conclusion

This study showed that adding bitcoin to a diversified portfolio of stocks and bonds would have consistently and significantly increased both the cumulative and risk-adjusted returns of that portfolio over any meaningful time period in bitcoin's history, provided a rebalancing strategy is in place.

This positive impact endures even in periods in which the price of bitcoin falls. For instance, investors who first allocated to bitcoin at its all-time closing high on December 16, 2017, and held through the end of this study on March 31, 2020, would still have slightly improved their portfolio's returns despite the fact that bitcoin is down more than 67% over that time period.

Bitcoin's ability to enhance portfolio returns even during difficult markets has been driven by its unique combination of high volatility, low correlations, and daily liquidity, which allows for volatility harvesting through disciplined rebalancing strategies.

In an effort to offer a more comprehensive view, this paper also analyzes bitcoin's portfolio impact through rolling holding periods instead of the typical arbitrary start and end dates. Both the magnitude and the consistency of bitcoin's contributions are remarkable.

Achieving this benefit does not require much: a reasonable time frame, a disciplined rebalancing strategy, and a well-thought-out position size. These are individual decisions for each investor, but we note some interesting historical patterns:

- **Time Frame: As holding periods increase above two years, the historical record of positive contributions quickly has approached 100%.** Bitcoin is a volatile asset and has experienced significant drawdowns in its history. It may experience more in the future. Still, allocating to bitcoin has improved a portfolio's cumulative and risk-adjusted returns in 100% of three-year periods, 97% of two-year periods, and 74% of one-year periods in bitcoin's history.
- **Rebalancing Frequency: Adding an asset with a significant degree of volatility in a portfolio makes rebalancing more critical than otherwise.** Generally, a quarterly rebalancing strategy has delivered a healthy balance between capturing bitcoin's asymmetric upside returns while keeping drawdowns under control.
- **Position Sizing: Maximum drawdowns are probably the main limiting factor for investors to have in mind when deciding how much bitcoin to add to their portfolio.** Although increasing bitcoin allocations tend to increase a diversified portfolio's cumulative returns and Sharpe ratio, the story is somewhat different with regard to maximum drawdowns. A rule of thumb is: Allocations below 5% have tended to have a minimal impact on maximum drawdowns; above 5%, however, the allocations become significant.

The overarching message from the data in this study is clear: Bitcoin may have a uniquely valuable role to play in enhancing the risk-adjusted returns of a Traditional Portfolio of stocks and bonds. Investment advisors can add immense value by helping their clients structure and manage allocations to this important new asset class.

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